exhausted under the action of stimulants, the longer the period that has elapsed since its detachment.

The author then proceeds to relate the nature of the strict analogy existing between electricity and nervous force. As electricity is developed under the influence of the nervous current in the organs of electrical fishes, so, as a converse of this phenomenon, electricity may develope the nervous force. After adverting to the well-known analogy subsisting in every particular between the phenomena of the electrical organ and those of muscles, he adverts to the old experiment of passing a current through the muscles of the thighs of a living animal, the positive pole being placed now above, now below, so that it may be supposed that the current passes in the two cases in opposite directions as regards the nervous filaments distributed in the muscles. He then points out that the effects of a current directed downwards, in the direct course of the nerves, are a strong contraction of the muscle traversed, and also of the *muscles of the leg below*; while the effect of a current in the opposite, or inverse direction, is *pain*, together with contractions less violent and always confined to the muscles traversed. The *contractions* (especially of the parts below) indicate a current of nervous force propagated towards the muscles, while the *pain* indicates a current towards the nervous centre. Now, bearing in mind that it has been proved by direct experiments that an electric current traversing a muscle never quits the muscular fibre to enter the nervous filaments, it seems clear that the phenomena just spoken of are exclusively owing to the *influence* exerted by the electricity passing through the muscles on the nervous force contained in the nerves; and also that this nervous force acts peripherad or centrad according to the direction of the electric current which excites it. The great importance of the conclusions drawn from these experiments consists in this, that they lead to the same law which establishes the analogy between nervous force and the electrical discharge of fishes. The paper concludes with some further considerations intended to confirm this law.

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January 17, 1850.

SIR RODERICK I. MURCHISON, Vice-President, in the Chair.

A paper was read, entitled "Researches respecting the Molecular constitution of the Volatile Organic Bases." By Dr. A. W. Hofmann. Communicated by Sir James Clark, Bart., F.R.S.

Chemists, although all acknowledging the existence of an intimate relation between the vegetable alkaloids and ammonia, are nevertheless divided in their opinions respecting the nature of this connection, two theories having been propounded upon the subject. According to the one, that of Berzelius, the bases would have to be considered as conjugated ammonias in which ammonia still pre-exists as such; while according to Liebig's views, these substances are represented as

amides, *i. e.* as ammonia in which one equivalent of hydrogen is eliminated and replaced by an equivalent of a compound radical.

The researches of the author prove that the theory of Berzelius is inadmissible, at all events for the volatile organic bases, inasmuch as in these substances ammonia ceases to exist as such. They show, moreover, that Liebig's view, although correctly expressing the constitution of by far the greater number of the volatile bases known, and presenting, when considered at the time it was first propounded, a wonderful anticipation of subsequent discovery, represents nevertheless only a special case of a much more general relation. The result at which the author has arrived is, *that ammonia is capable of losing either* 1 (*Liebig's case*) *or* 2 *or* 3 *equivs. of hydrogen which are respectively replaced by* 1, 2 *or* 3 *equivs. of the same, or various compound radicals, a variety of substances apparently endless being produced, in which its fundamental property* (*the basic character*) *is retained, although modified by the number of radicals introduced and their position in the scale of organic compounds.*

In support of this statement, he adduces the artificial construction of thirteen new organic alkaloids, formed by a method which affords the means of increasing the number of these substances to an indefinite extent. This method consists in exposing ammonia to the action of the chlorides, bromides or iodides of the alcohol radicals, which remove 1 equivalent of hydrogen of the latter, as hydrochloric, hydrobromic, &c. acid, while the remaining constituents, assuming the alcohol-radical, give rise to the formation of an organic base which unites with the hydrogen acid.

By subjecting the new base itself to a similar treatment, another equivalent of the two remaining equivalents of hydrogen may be removed, a second organic base being formed, which in its turn gives rise to a third.

The changes which the ammonia undergoes in these various processes may be represented graphically by the following simple formulæ, X, Y and Z, denoting generally compound radicals.

$$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N+XBr=\left.\begin{matrix}H\\H\\X\end{matrix}\right\}N.HBr.$$

$$\left.\begin{matrix}H\\H\\X\end{matrix}\right\}N+YBr=\left.\begin{matrix}H\\X\\Y\end{matrix}\right\}N.HBr.$$

$$\left.\begin{matrix}H\\X\\Y\end{matrix}\right\}N+ZBr=\left.\begin{matrix}X\\Y\\Z\end{matrix}\right\}N.HBr.$$

For the illustration of these general formulæ, one of the numerous sets of experiments which the author has communicated in his paper may be quoted in which X=Y=Z. Ammonia, when exposed to the action of bromide of ethyl (hydrobromic ether), is converted into hydrobromate of ethylamine, *i. e.* ammonia in which 1 equivalent of hydrogen is replaced by ethyl, a compound which was first observed by M. Wurtz under perfectly different circumstances. Ethylamine, treated again with bromide of ethyl, yields a new alkaloid diethyla-

mine, *i. e.* ammonia in which 2 equivalents of hydrogen are replaced by ethyl, and which, under the influence of a further quantity of bromide of ethyl, lastly is transformed into triethylamine, or ammonia in which the whole of the hydrogen is replaced by ethyl. This is a most powerful alkali, whose properties resemble those of caustic potassa.

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January 24, 1850.

RICHARD OWEN, Esq., Vice-President, in the Chair.

The following communications were read:

1. "Observations on the Freezing of the Albumen of Eggs." By James Paget, Esq., Professor of Anatomy and Surgery to the Royal College of Surgeons. Communicated by Thomas Bell, Esq., Sec. R.S. &c.

The object of this paper is to illustrate a peculiar property of the albumen of the eggs of birds, a property which seems to have its purpose in preserving them from the injurious effects of very low temperatures.

Mr. Hunter observed that a fresh egg will resist freezing longer than one which has been previously frozen and thawed; and he referred this fact to the 'vital power' of the egg in the first case, and the destruction of that power by freezing in the second. The author's experiments confirm those of Mr. Hunter, and prove, also, that when fresh eggs are exposed to very low temperatures, and also in the case of eggs which are decayed, or putrid, or the contents of which have been much altered by mechanical force or by electricity, a shorter time is sufficient for the freezing of such eggs, than is necessary for the freezing of those which are uninjured.

An examination of the rates at which heat was lost by the several eggs, exposed to temperatures varying from zero to 10° Fahr., showed that fresh eggs, though they resist freezing longer than any others, yet lose heat more quickly; and that their resistance to freezing is due to the peculiar property of their albumen, the temperature of which may be reduced to 16° Fahr., or much lower without freezing, although its proper freezing-point is at or just below 32°. Other than fresh eggs lose heat comparatively slowly, but freeze as soon as their temperature is reduced to 32°; fresh eggs lose heat more quickly, but may be reduced to 16° or lower; then, at the instant of beginning to freeze, their temperature rises to 32°.

That this peculiarity of fresh eggs is not due to vital properties, is proved by experiments which show that certain injuries, such as mechanical violence, addition of water, and others, which spoil their powers of resisting freezing, do not prevent eggs from being developed in incubation. By the same and other experiments, which are related, it is made probable that the peculiarity depends on the mechanical properties of the albumen; for, whatever makes the albumen more liquid than it is naturally in the fresh egg, destroys the power of resisting freezing.